

LAB4 WRITEUP

Submission Questions:

18.

a) What operating system (including revision) did you use for your code development?

Ans: Windows 11

b) What compiler (including revision) did you use?

Ans: SDCC

c) What exactly (include name/revision if appropriate) did you use to build your code (what IDE, make/makefile, or command line)?

Ans: STM32CubeIDE 1.13.2 and CodeBlocks:SDCC

d) Did you install and use any other software tools to complete your lab assignment?

Ans No.

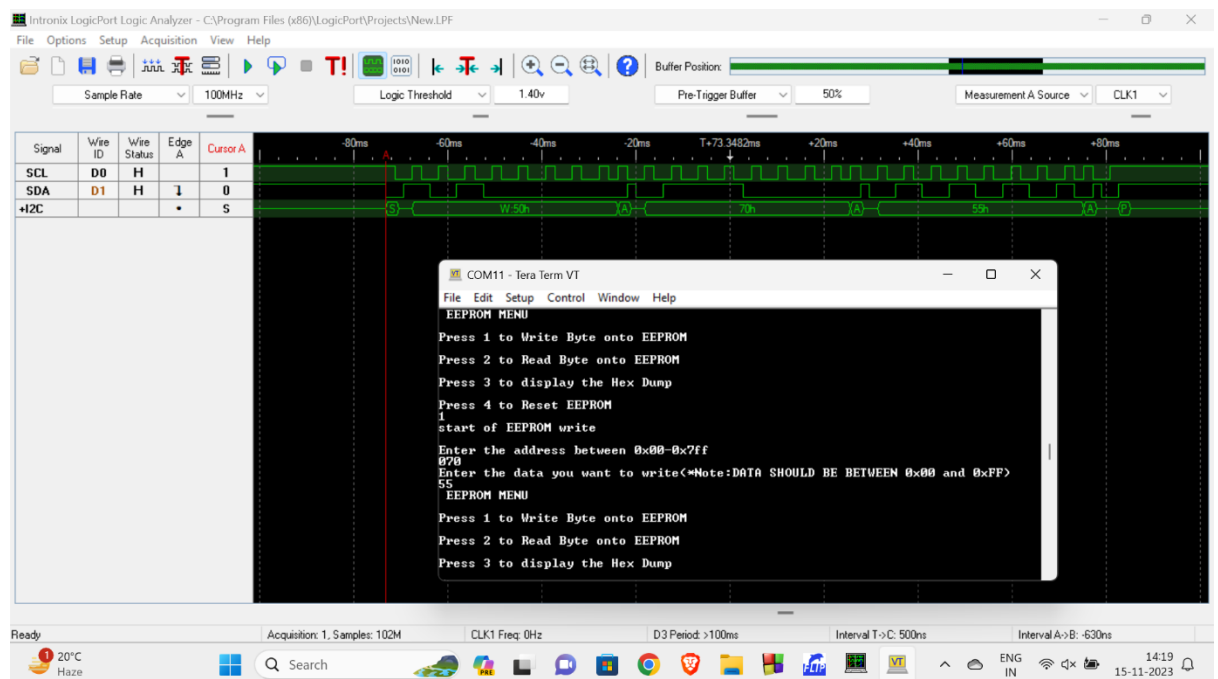
e) Did you experience any problems with any of the software tools? If so, describe the problems.

Ans: No

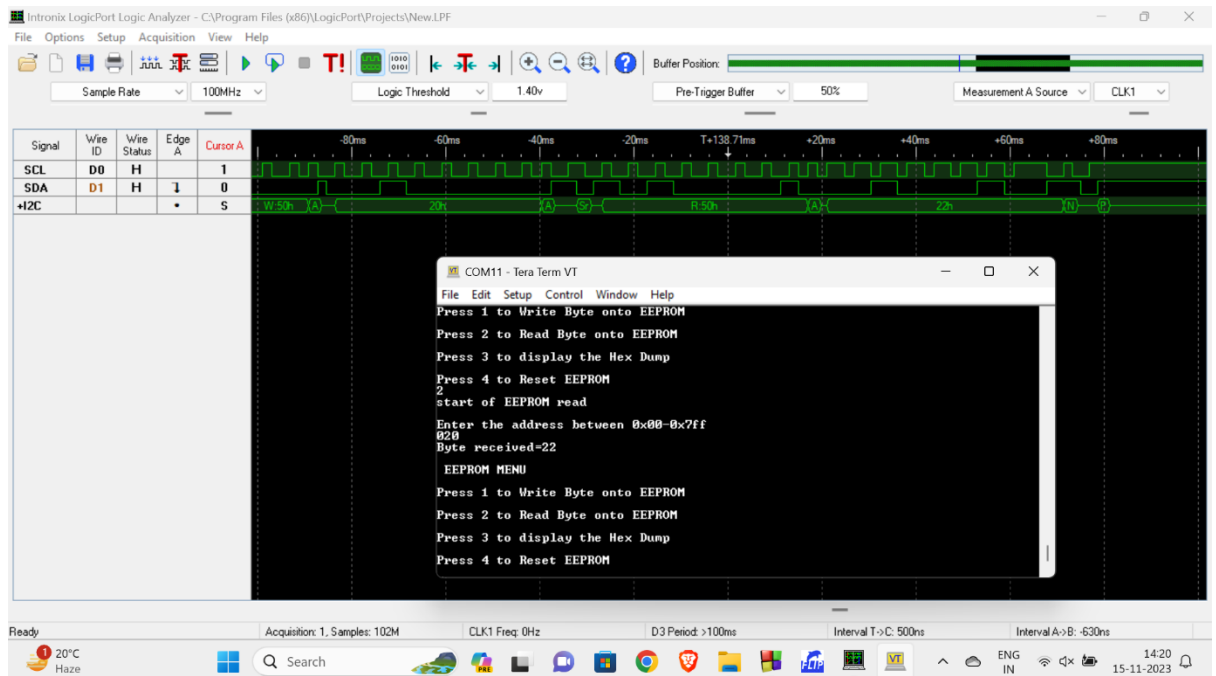
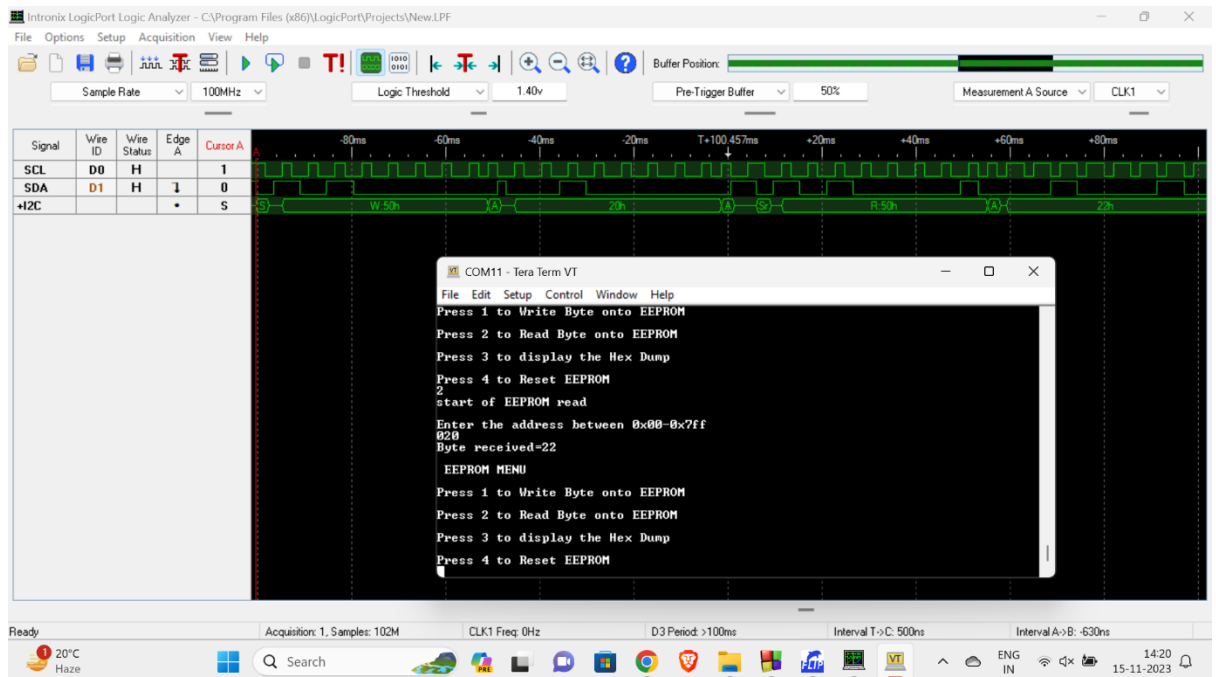
Pictures/Screenshots:

PART1: EEPROM

1. Screenshot of Terminal output and Logic analyzer timing diagrams during EEPROM write.

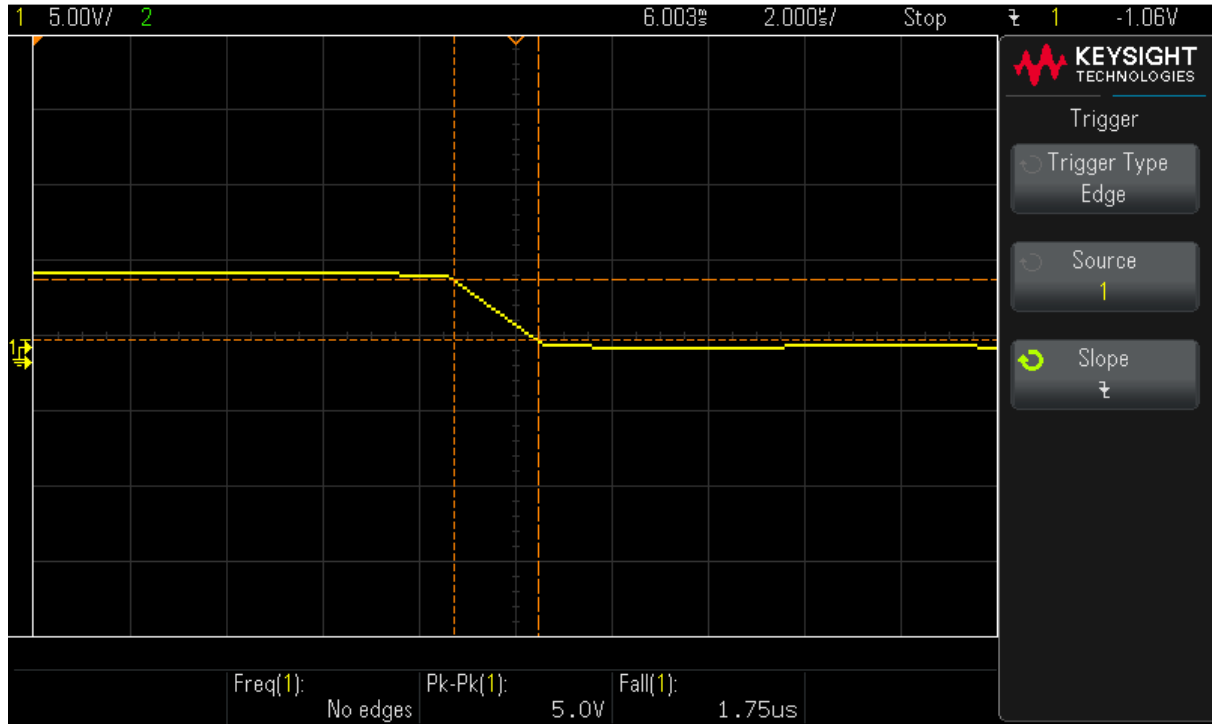


2. Screenshot of Terminal output and Logic analyzer timing diagrams during EEPROM read.



4. Oscilloscope picture of SDA falltime

DSO-X 11026, CN57276342: Thu Nov 16 04:00:26 2023



Part 2:

1. Screenshots of Terminal output of LCD.

```
COM11 - Tera Term VT
File Edit Setup Control Window Help

Welcome to PAULMON2 v2.1, by Paul Stoffregen
See PAULMON2.DOC, PAULMON2.EQU and PAULMON2.HDR for more information.

Program Name      Location      Type
List              1000        External command
Single-Step       1400        External command
Memory Editor (UI100) 1800        External command

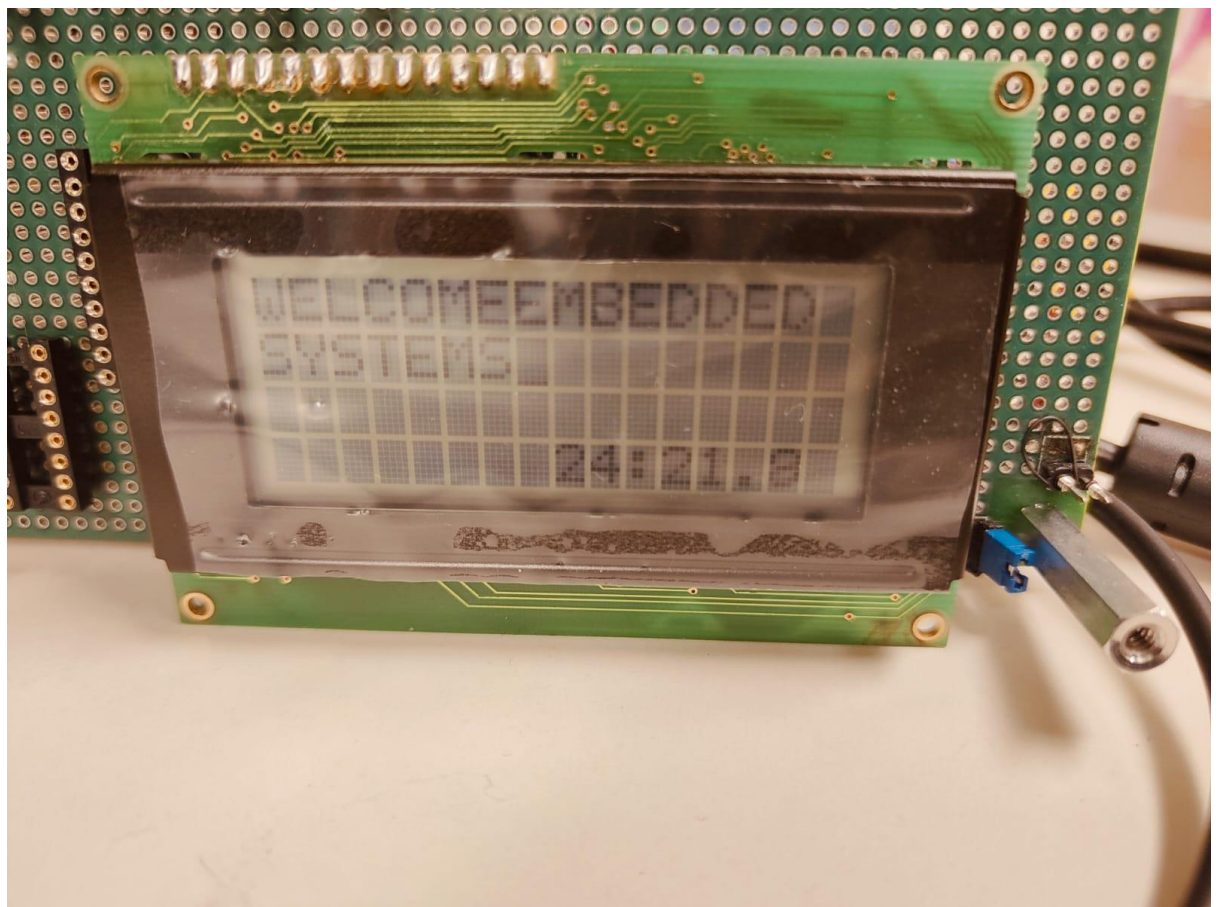
PAULMON2 Loc:2000 > Jump to memory location
Jump to memory location (2000), or ESC to quit: 2000
Running program:

WELCOME
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 1

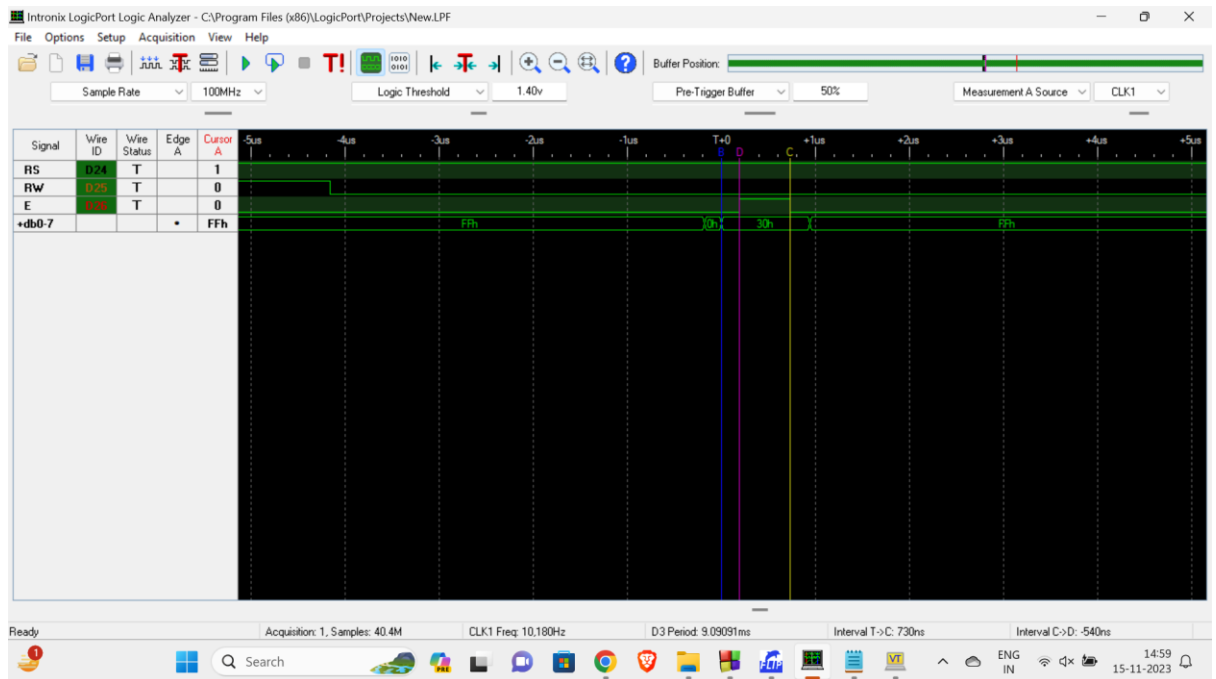
LCD Jump address
Enter the address: 93
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 1
```

```
COM11 - Tera Term VT
File Edit Setup Control Window Help
LCD Jump address
Enter the address: 93
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 3
LCD Jump co-ordinates
Enter X coordinate(row):2
Enter Y coordinate(row):10
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 3
LCD Jump co-ordinates
Enter X coordinate(row):1
Enter Y coordinate(row):10
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 5
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 2
Menu:
1. LCD Jump address
2. clear LCD
3. LCD Jump co-ordinates
4. Put string
5. Start or stop time
6. Reset time
Entered input: 
```

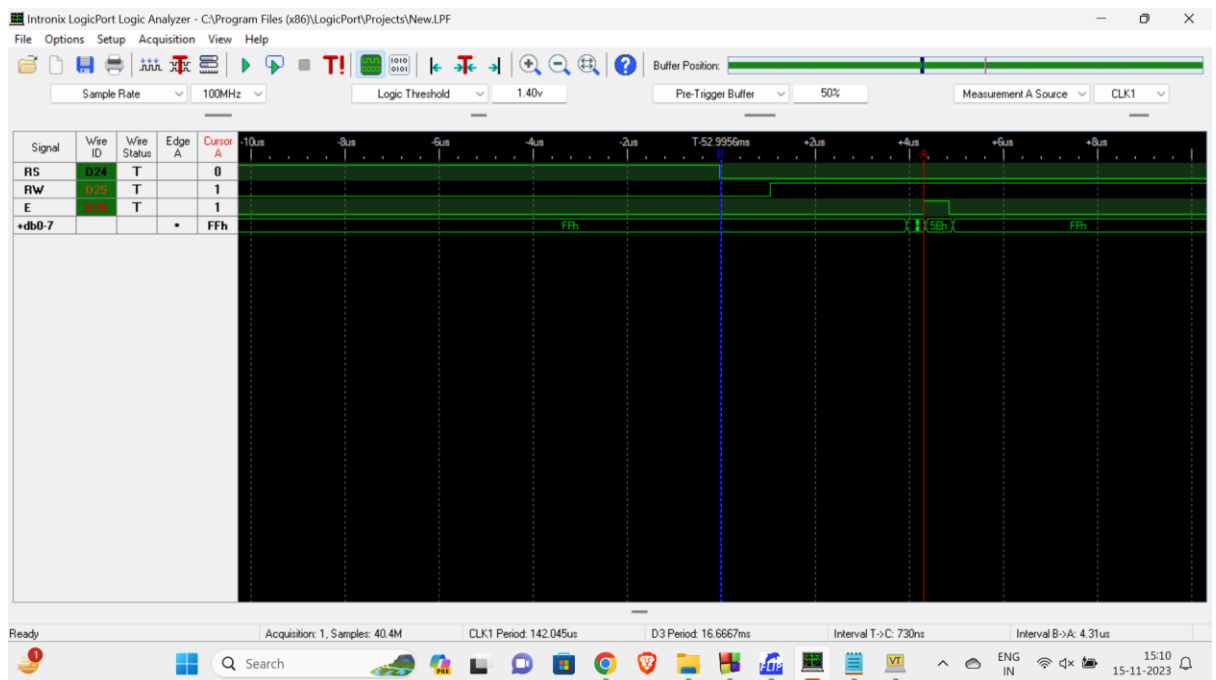
2.Screenshot of on-board LCD screen.



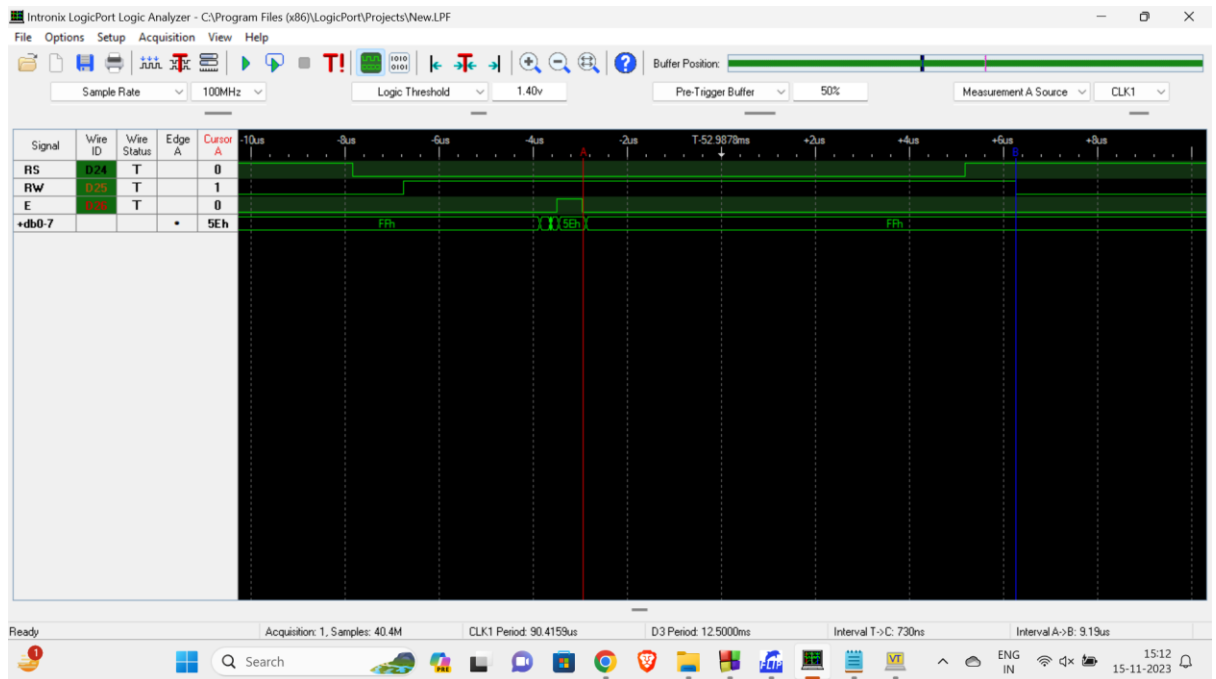
4. Logic analyser screenshot measuring the pulse width of Enable which should be a minimum of 230ns.
Enable pulse width = 540ns (meets the requirements)



5. Logic analyser screenshot measuring the Address setup time which should be a minimum of 40ns.
Address setup time = 4.31us (meets the requirements)



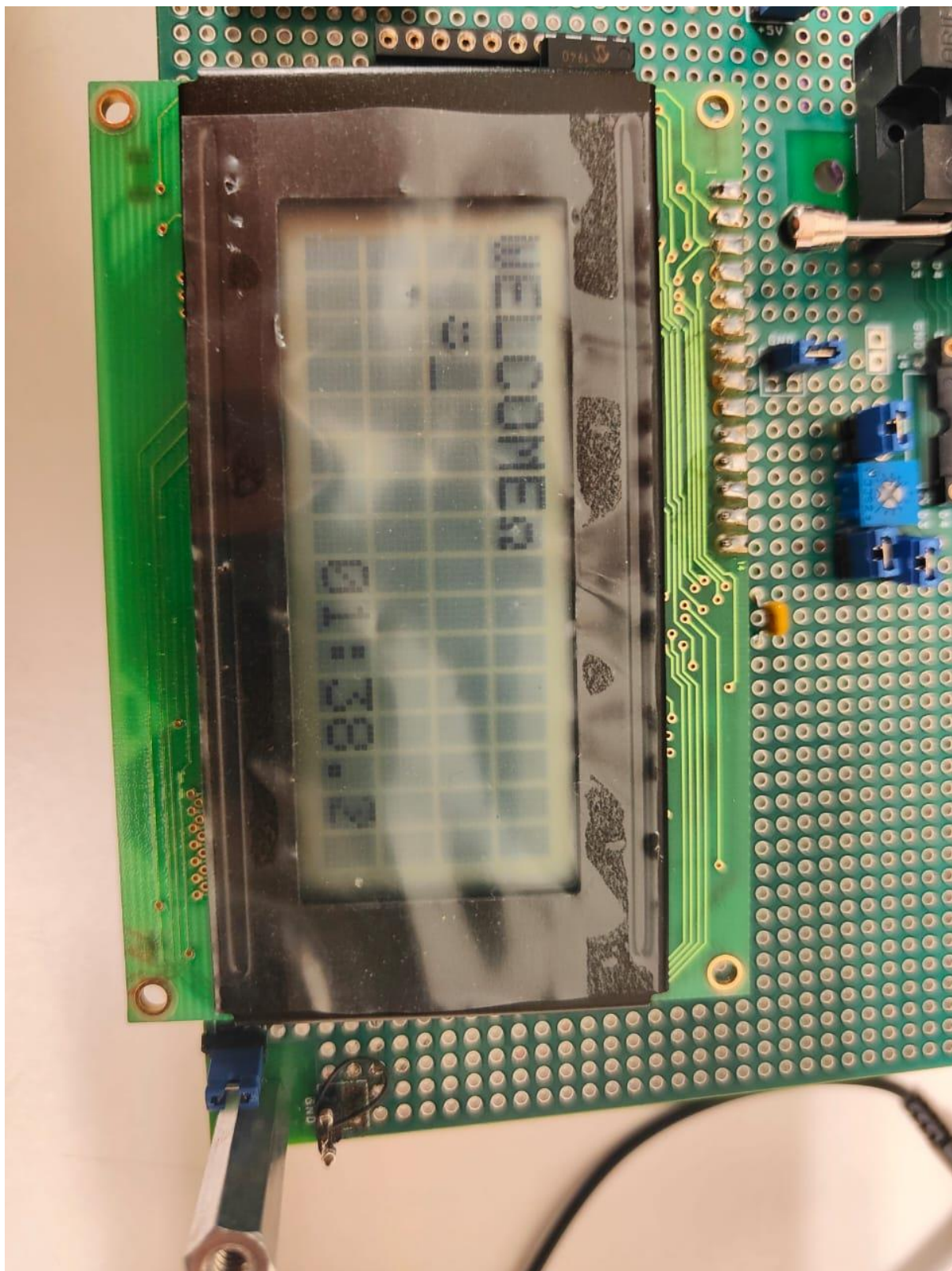
6. Logic analyser screenshot measuring the Address hold time which should be a minimum of 10ns.
Address setup time = 9.19us (meets the requirements)



PART 3:

1. Screenshots of output terminal for creating a custom character.

```
COM11 - Tera Term VT
File Edit Setup Control Window Help
Row 6: 1B
Row 7: 00
Custom character created with code 0.
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 1
LCD Jump address
Enter the address: C2
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 9
Create Custom Character
Enter character code (0-7): 1
Enter pixel pattern for character 1 (in hex):
Row 0: 00
Row 1: 00
Row 2: 00
Row 3: 00
Row 4: 11
Row 5: 0E
Row 6: 00
Row 7: 00
Custom character created with code 1.
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 1
```

Screenshot of Terminal output with CGRAM Hexdump and DDRAM Hexdump.

```
COM11 - Tera Term VT
File Edit Setup Control Window Help
Row 3: 00
Row 4: 11
Row 5: 0E
Row 6: 00
Row 7: 00
Custom character created with code 1.
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 8
CGRAM Hexdump
00: 00 00 0E 11 11 00 1B 00 20 20 20 20 31 2E 20 20
10: FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
20: 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
30: FF FF FF FF FF FF DF 7F FF FF FF FF FF FF FF FF
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 7
DDRAM Hexdump
00: 57 45 4C 43 4F 4D 45 00 20 20 20 20 20 20 20 20
10: 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
20: 20 20 20 20 20 20 20 20 20 20 20 01 20 20 20 20
30: 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20 20
40: 30 32 3A 32 32 2E 38 20 20 20 20 20 20 20 20 20
Menu:
1. LCD Jump address
2. Clear LCD
3. LCD Jump coordinates
4. Put string
5. Start or stop time
6. Reset time
7. LCD DDRAM Dump
8. LCD CGRAM Dump
9. Create custom character
Entered input: 1
```

2. Screenshots of Terminal output for DAC implemented using SPI protocol.

```
COM11 - Tera Term VT
File Edit Setup Control Window Help

Welcome to PAULMON2 v2.1, by Paul Stoffregen
See PAULMON2.DOC, PAULMON2.EQU and PAULMON2.HDR for more information.

Program Name      Location      Type
List              1000         External command
Single-Step       1400         External command
Memory Editor (V100) 1800         External command

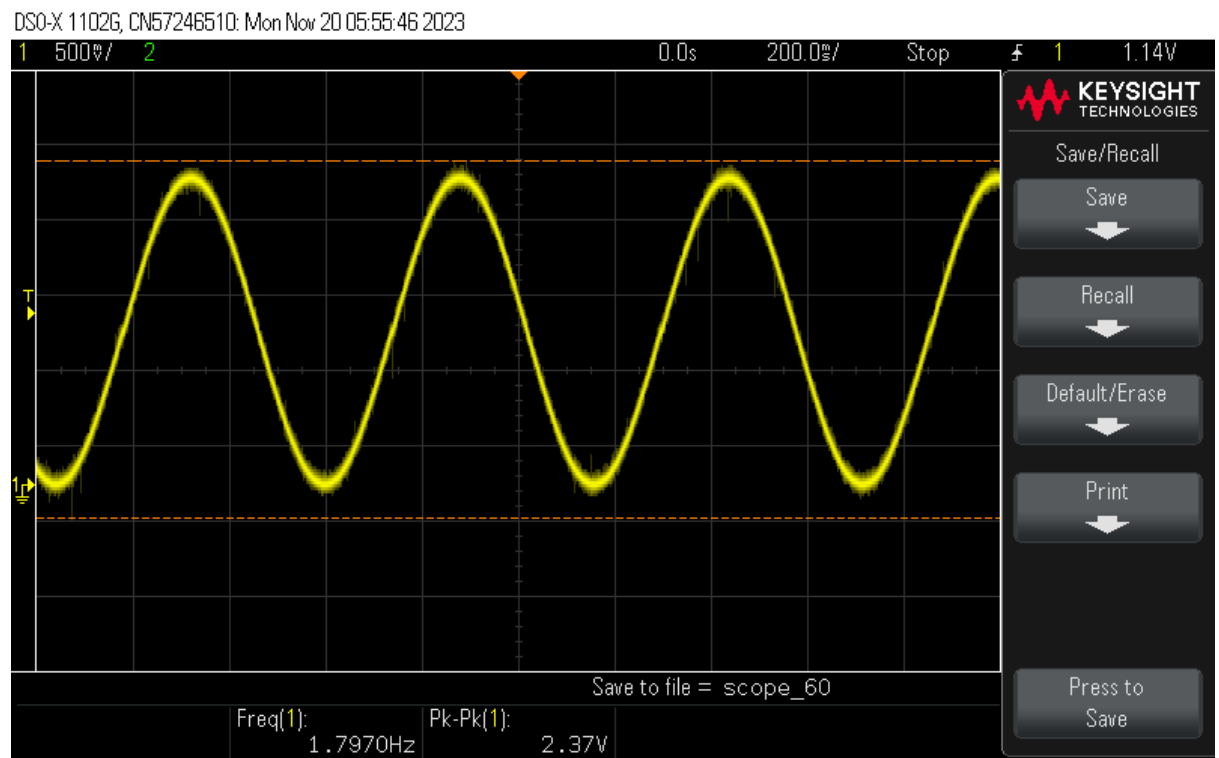
PAULMON2 Loc:2000 > Jump to memory location
Jump to memory location (2000), or ESC to quit: 2000
Running program:

ESD Lab 4 Supplemental
Press '1' for Next wave.
Press '2' to Increase DAC voltage.
Press '3' to Decrease DAC voltage.
Press '4' to Display Menu

next wave
gain increased
gain increased
gain decreased
Press '1' for Next wave.
Press '2' to Increase DAC voltage.
Press '3' to Decrease DAC voltage.
Press '4' to Display Menu

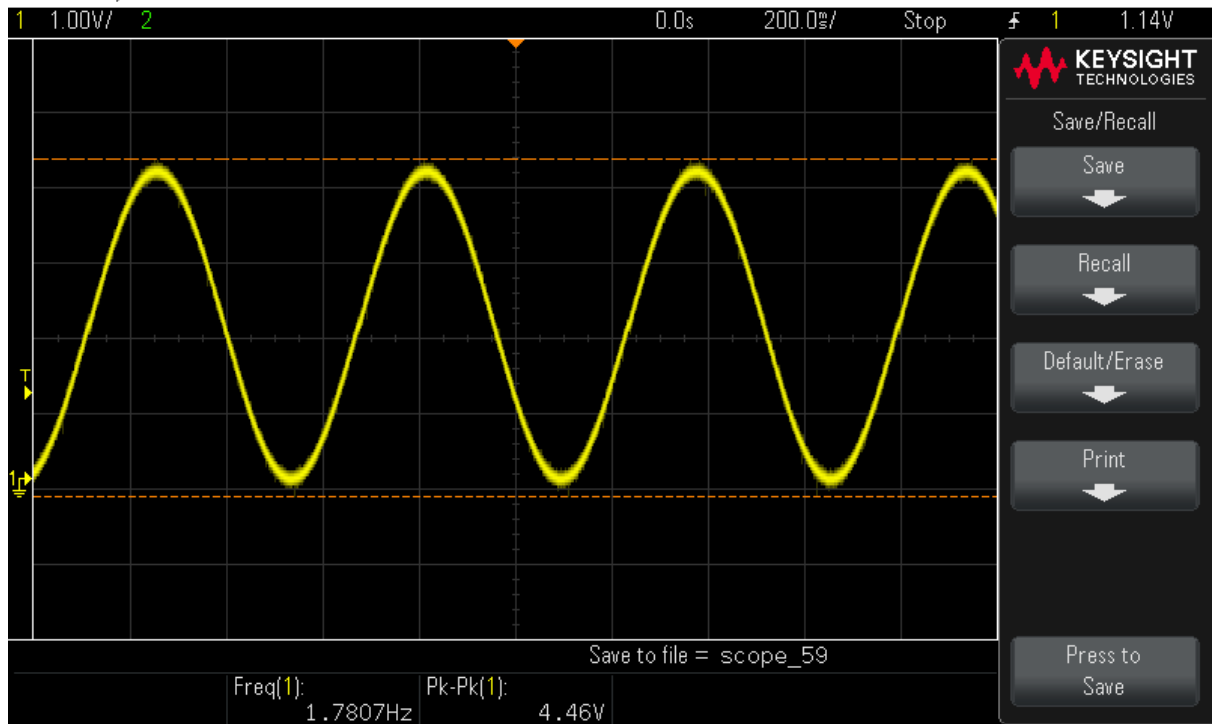
next wave
next wave
next wave
next wave
next wave
next wave
```

Oscilloscope picture of DAC used to generate Sinusoidal wave.



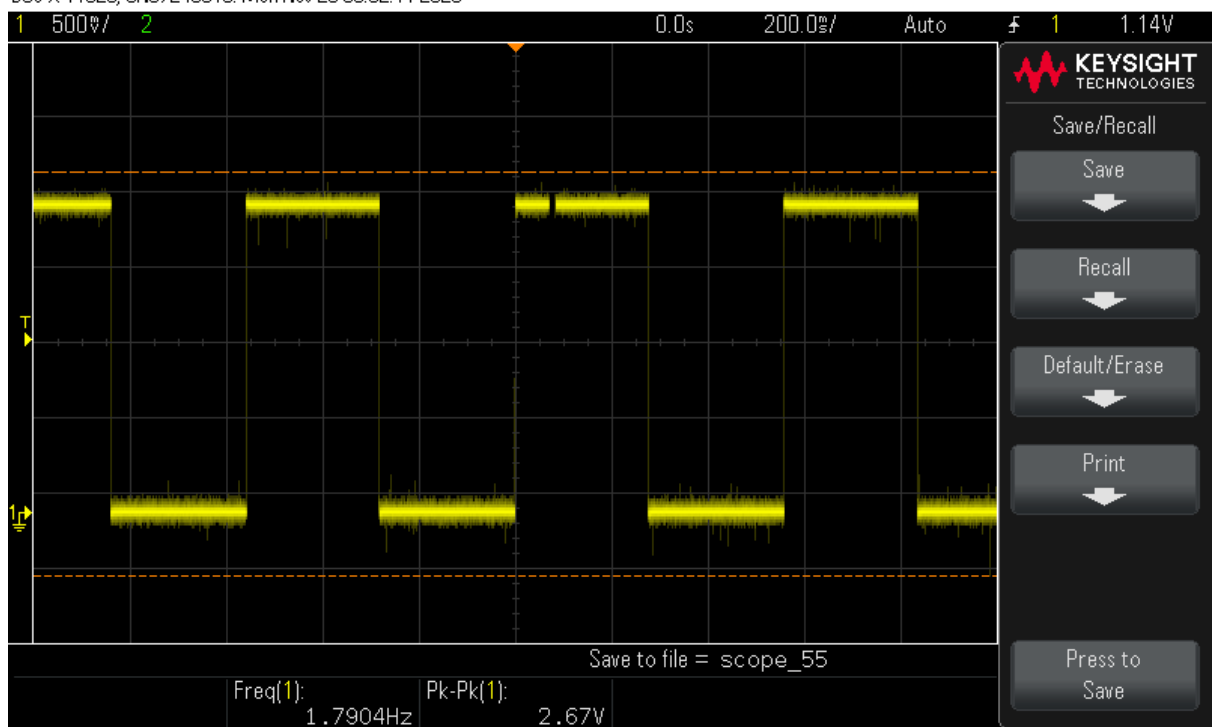
Oscilloscope picture of DAC used to generate Sinusoidal wave with increased gain.

DSO-X 1102G, CN57246510: Mon Nov 20 05:54:59 2023

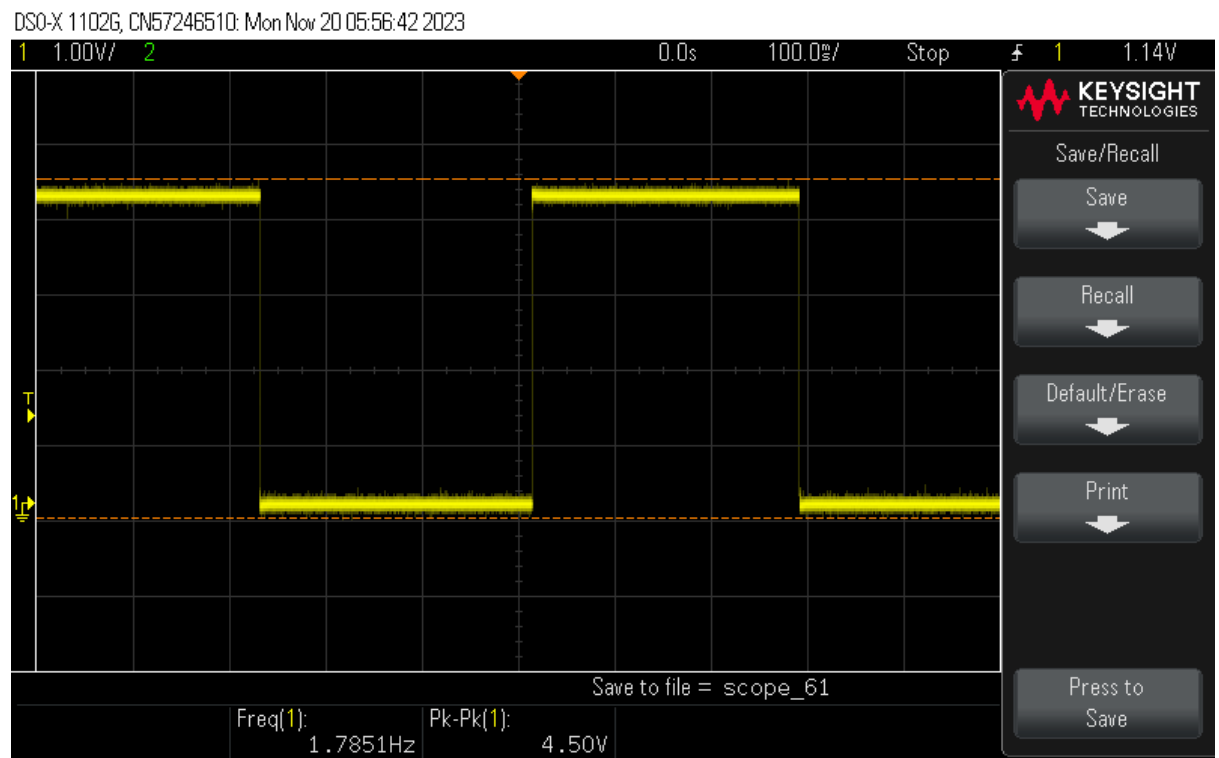


Oscilloscope picture of DAC used to generate a square wave.

DSO-X 1102G, CN57246510: Mon Nov 20 05:52:11 2023

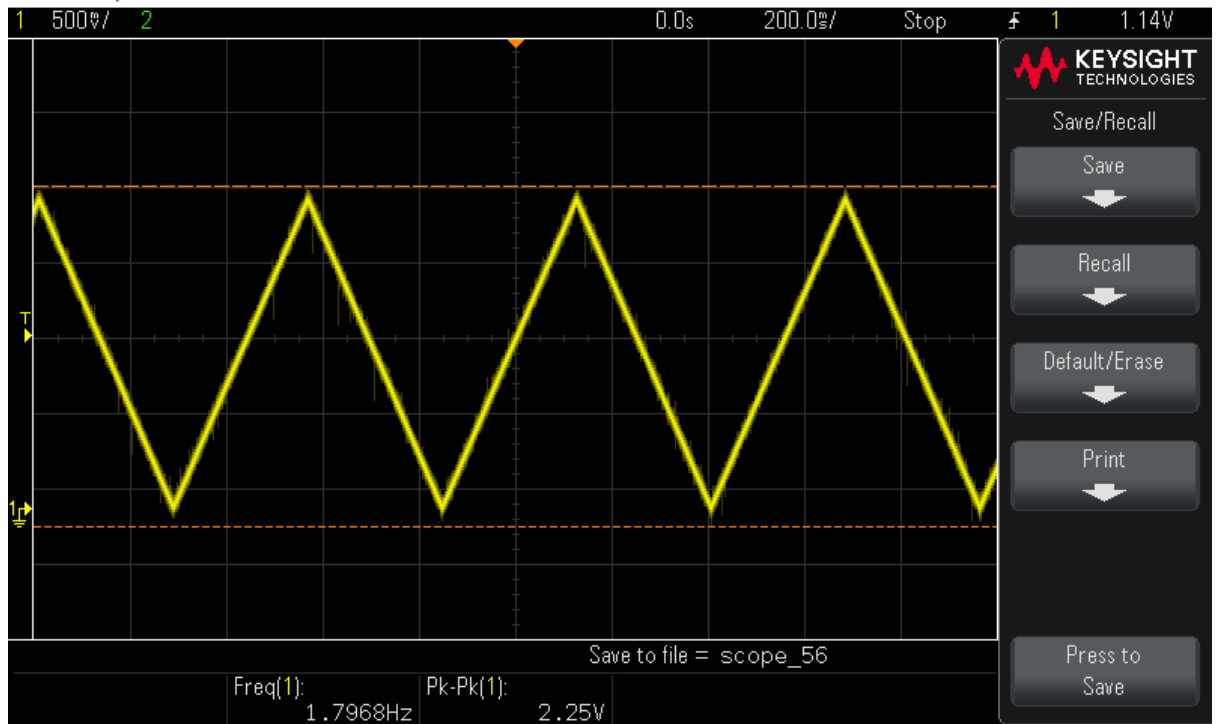


Oscilloscope picture of DAC used to generate a square wave with increased gain.



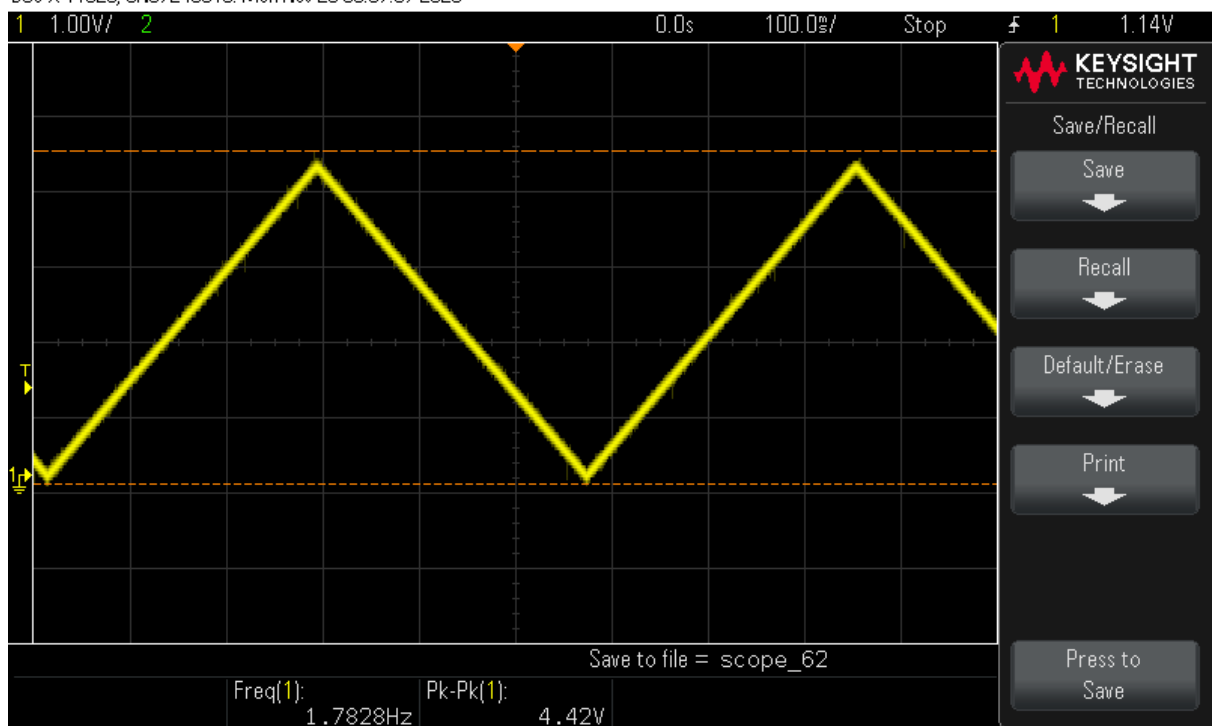
Oscilloscope picture of DAC used to generate the triangular wave.

DSO-X 1102G, CN57246510: Mon Nov 20 05:53:02 2023



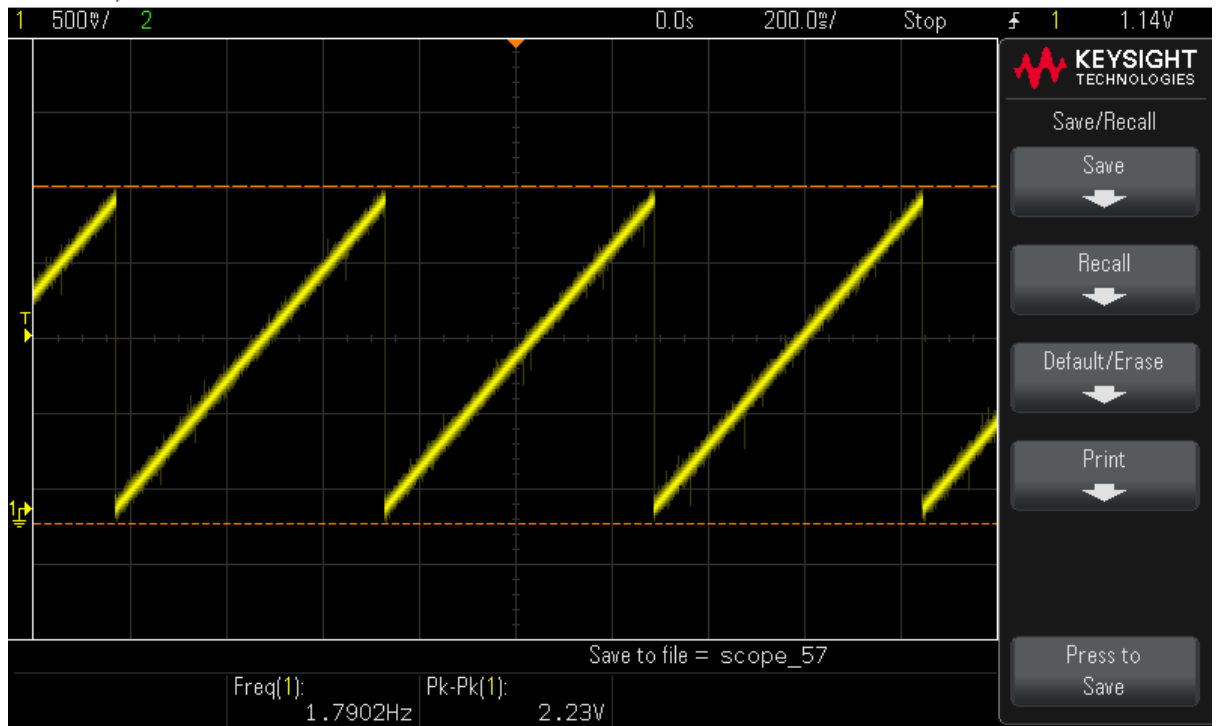
Oscilloscope picture of DAC used to generate the triangular wave with increased gain.

DSO-X 1102G, CN57246510: Mon Nov 20 05:57:07 2023



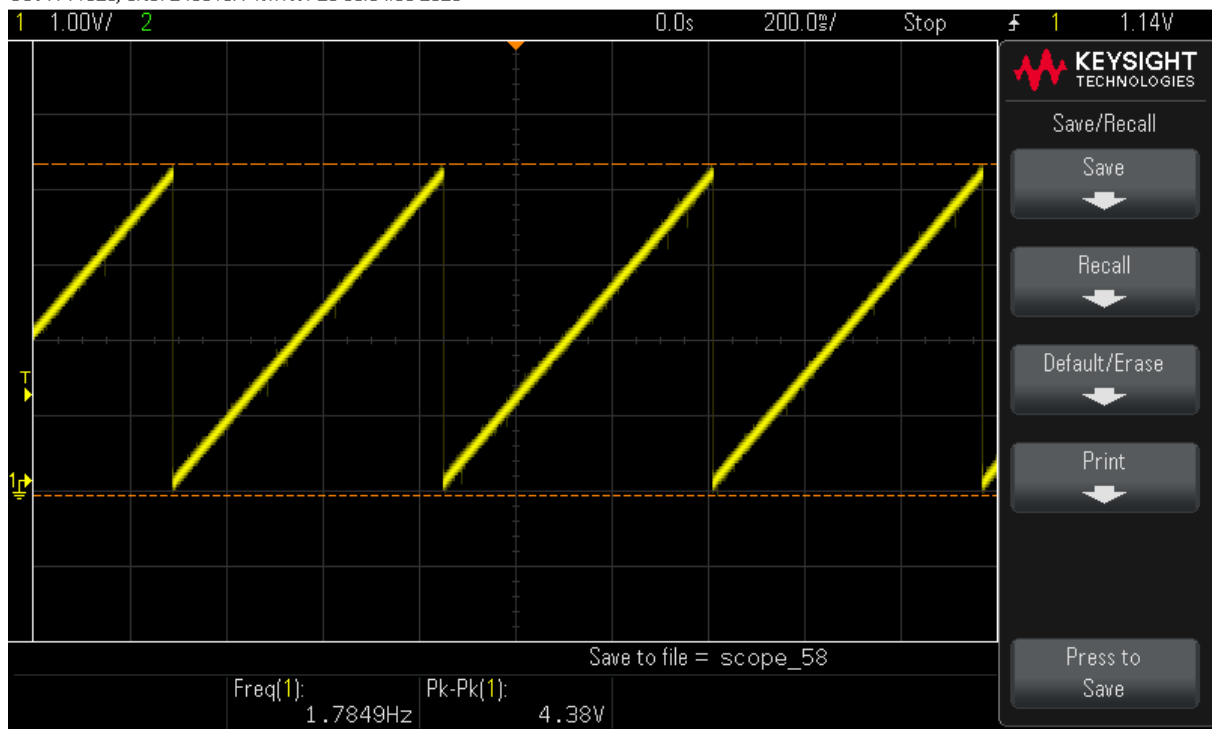
Oscilloscope picture of DAC used to generate the sawtooth wave.

DSO-X 1102G, CN57246510: Mon Nov 20 05:53:53 2023



Oscilloscope picture of DAC used to generate the sawtooth wave with increased gain.

DSO-X 1102G, CN57246510: Mon Nov 20 05:54:33 2023



3. Screenshot of Terminal output for I/O expander.

```
COM11 - Tera Term VT
File Edit Setup Control Window Help

Welcome to PAULMON2 v2.1, by Paul Stoffregen
See PAULMON2.DOC, PAULMON2.EQU and PAULMON2.HDR for more information.

Program Name      Location      Type
List              1000        External command
Single-Step       1400        External command
Memory Editor <UT100> 1800        External command

PAULMON2 Loc:2000 > Jump to memory location
Jump to memory location <2000>, or ESC to quit: 2000
Running program:

EEPROM MENU
Press 1 to Write Byte onto EEPROM
Press 2 to Read Byte onto EEPROM
Press 3 to display the Hex Dump
Press 4 to Reset EEPROM
Press 5 to I/O expander write
Press 6 to I/O expander read
$
I/O expander write mode
Enter Data : 40
I/O expander Write complete

EEPROM MENU
Press 1 to Write Byte onto EEPROM
Press 2 to Read Byte onto EEPROM
Press 3 to display the Hex Dump
Press 4 to Reset EEPROM
Press 5 to I/O expander write
Press 6 to I/O expander read
$
I/O expander Read mode
Data read : BF
EEPROM MENU
Press 1 to Write Byte onto EEPROM
Press 2 to Read Byte onto EEPROM
Press 3 to display the Hex Dump
Press 4 to Reset EEPROM
Press 5 to I/O expander write
Press 6 to I/O expander read
$
```

SIGNIFICANT LEARNINGS:

- I have learned how to write a driver and user interface for I2C protocol using EEPROM.
- I have learned to integrate LCD with 8051 and write the data on the LCD screen.
- I have learned to integrate a real-time clock with an LCD and control its operation like start, stop, and reset.
- I have learned to create a custom character and display it on the LCD.
- I have learned how to write a driver and user interface for SPI protocol using DAC.
- I have learned how to generate various waveforms like sinusoidal, square, triangular, and saw-tooth using DAC.
- I have learned how to implement an I/O expander using an I2C protocol that offers more digital I/O pins than what is available on the microcontroller.